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Survey Report

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A SURVEY FOR INSECT AND DISEASE PROBLEMS WYMAN AND SOUTHERN MICHIGAN NURSERIES

by

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This report summarizes the results of a survey conducted in September 1978 and June through August 1979.

BACKGROUND

Root rot of white pine seedlings was noted at Wyman Nursery in August of 1977. The beds were treated with a captan drench to suppress pathogens as the use of fumigants was unacceptable to DNR personnel. Soil tests indicated that a species of Fusarium might be the causal agent. It was agreed that the 2-0 seedlings and the new 1-0 seedlings should be examined in early summer 1978.

The beds affected in 1977 and newly planted beds were examined in June of 1978. At that time, no new mortality was evident, but a tip necrosis on the 1-0 white pine was observed. The roots of both the 1-0 and 2-0 white pine were examined for root rot. At that time, there was no additional root rot in the roots of the 2-0 stock and the roots of the 1-0 stock looked excellent. Over 50% of the rootlets were mycorrhizal and there were no indications of root rot.

In August, white pine seedlings at Wyman and Southern Michigan Nurseries were becoming chlorotic. Analyses of the soil and some seedlings by Bob Anderson, S&PF, resulted in the isolation of the fungi Sclerotium and Fusarium.

The incidents noted above led to a request that S&PF investigate the occurrence of insects and diseases in the State nurseries and determine if their occurrence was a limiting factor to nursery stock production.

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OBJECTIVES

1. To detect insects and diseases affecting conifers at Wyman and Southern Michigan Nurseries.

2. To quantify the damage caused by the insects and diseases found at the nurseries.

3. To recommend appropriate course of action.

MATERIALS AND METHODS

The 1-0 stock was examined approximately 7 to 10 days after germination and again at the end of the growing season. The 2-0 stock was examined in August of 1979.

Initially, all units (a series of 9 beds of seedlings) were examined for insect or disease damage to the above-ground portions of the plants. Units with evidence of problems were noted and scheduled for a more intensive examination. Next, seedlings were lifted from five different points in each unit to detect gross problems in the root systems. Again, units with such problems were referenced for intensive examination. For species in which evidence of gross damage was lacking, only one unit was sampled intensively. For species showing gross damage, 50% of the units were sampled intensively. Table 1 shows the number of units sampled intensively.

Intensive sampling consisted of examination of seedlings from ten points (randomly selected) within the unit. At each point, using a standard inventory frame (6 in x 4 ft), the following data were taken: number of apparently healthy seedlings, number of stunted and/or chlorotic seedlings, number of dead seedlings, number of seedlings killed by cutworms, number of seedlings damped-off (1-0 stock), and number of seedlings with bud mortality.

Seedlings exhibiting symptoms (chlorois, stunting, root rot) were lifted, kept cool, and taken to the laboratory for isolation of possible pathogens. Isolations were made from three areas of the root system of 15 white pine and 15 red pine seedlings exhibiting damping-off (1-0) or root rot symptoms (2-0). PCNB agar (selective for Fusarium) and PDA (non-selective) were used as the isolation media.

In order to address the question of whether seedlings stunted at germination would remain smaller than normal seedlings, 15 stunted and non-stunted seedlings were tagged 10 days after germination and examined two months later.

RESULTS

Stunting

The most significant problem noted in both nurseries was stunting of 1-0 seedlings (all species) and a stunting, chlorosis, and subsequent mortality of 2-0 white pine. Tables 1 and 2 summarize the percentage of seedlings affected at each nursery.

Table 1.--Percentage of seedlings at Southern Michigan Nursery showing various symptoms of insect and disease attack

Tree species	Age class	No. of units	Normal seedlings (%)	Abnormal seedlings (%)				
				Chlorotic or stunted	Cutworms	Damped off	Dead	Bud mortality
Jack Pine	1-0	2	99	0	0	1	0	NA[1/]
Red Pine	1-0	2	73	17	1	9	0	NA
White Spruce	1-0	2	60	39	0	1	0	NA
White Pine	1-0	1	70	30	0	0	0	NA
Jack Pine	2-0	2	100	0	NA	NA	0	0
Red Pine	2-0	2	87	0	NA	NA	6	7
White Pine	2-0	2	94	5	NA	NA	1	0

[1/] Not Applicable

Table 2.--Percentage of seedlings at Wyman Nursery showing various symptoms of insect and disease attack.

Tree species	Age class	No. of units	% of Seedlings affected: Normal	Chlorotic or stunted	Cutworms	Damped off	Dead	Bud mortality
Jack pine	1-0	2	92	8	0	less than 1%	0	NA[1/]
Red pine	1-0	2	81	13	5	1	0	NA
White spruce	1-0	1	25	75	0	0	0	NA
White pine	1-0	2	83	17	0	0	0	NA
Jack pine	2-0	2	100	0	NA	NA	0	0
Red pine	2-0	2	84	0	NA	NA	0	16
White spruce	2-0	2	61	22	NA	NA	17	0
White pine	2-0	2	65	34	NA	NA	1	0

[1/] Not Applicable

Stunting was most prevalent in white spruce at Wyman Nursery (75% of the seedlings affected) and this was probably reflected by the 17% mortality noted in 2-0 white spruce. First year red and white pine were also affected (13% and 17% respectively), but there was little ensuing mortality in these species.

Thirty-nine percent of the 1-0 white spruce at Southern Michigan Nursery was stunted. The two-year old white spruce was not evaluated so the degree of ensuing mortality is unknown. White pine was the next most severely stunted species (30%), followed by red pine (17%). Jack pine was unaffected.

Of the seedlings which were stunted at the time of germination, 60% were still abnormal 2 months later. Chlorosis and stunting continued to be a problem in 2-0 white spruce and white pine, especially at Wyman Nursery, where up to 34% of the 2-0 white pine and 22% of the 2-0 white spruce was stunted and/or chlorotic.

Bud Damage

Sixteen percent of the 2-0 red pine at Wyman and 7% at Southern Michigan had bud mortality. Although the bud mortality was suspected to be due to a boring insect, the insect was not present and a positive identification was not made.

Damping-off and Cutworms

Damping-off caused the loss of 9% of the red pine at Southern Michigan. Cutworms caused the loss of 5% of the red pine at Wyman Nursery and 1% of the red pine at Southern Michigan.

Pathogens

Isolations from damped-off and chlorotic 1-0 red pine at Southern Michigan Nursery yielded primarily *Fusarium oxysporum*, *F. solani*, and *F. roseum* var *sambucinum*. The latter was the organism most frequently isolated from 1-0 white pine at Wyman (Table 3).

Table 3.--Fungi isolated (% of all isolations) from 1-0 red pine from Southern Michigan Nursery and 1-0 white pine from Wyman Nursery.

Organism isolated	Red pine (Southern Michigan) Normal	Chlorotic	Damped-off	White pine (Wyman) Normal	Chlorotic
None (Sterile tissue)	22	7	0	17	2
Fusarium oxysporum	40	22	54	8	11
F. solani	0	9	8	28	2
F. roseum var sambucinum	11	16	0	0	51
F. tricinctum	0	2	0	0	0
Cylindrocarpon	0	0	4	0	0
Trichoderma	3	7	13	19	2
Penicillium	0	4	0	8	9
Bacteria	24	33	4	20	20

Second year white pine from both Wyman and Southern Michigan yielded F. oxysporum and F. roseum var equisetti most frequently.

F. roseum var acuminatum was also common from Wyman 2-0 white pine (Table 4).

Table 4.--Fungi isolated (% of all isolations) from 2-0 white pine from Southern Michigan and Wyman Nurseries.

Organism isolated	White pine (Southern Michigan) Normal	Chlorotic	White pine (Wyman) Normal	Chlorotic
None (Sterile tissue)	2	0	5	0
Fusarium oxysporum	66	60	51	58
F. solani	2	2	0	0
F. roseum var equisetti	0	8	0	16
F. roseum var acuminatum	0	2	27	9
Cylindrocarpon	0	0	5	0
Trichoderma	18	20	2	11
Penicillium	0	6	5	0
Bacteria	12	0	5	6

DISCUSSION

The problems noted in this evaluation are common in other State and Federal nurseries in the Lake States.

The four major problems (stunting, damping-off, white pine chlorosis, and bud mortality of red pine) will be discussed separately.

Stunting

This problem, most significant in white spruce, but affecting all species except jack pine, is very subtle and thus more difficult to detect and evaluate. The stunting and chlorosis noted here have been seen in nurseries nationwide, and the impact of this abnormality has varied a great deal.

In Wisconsin nurseries, thousands of stunted seedlings died when subjected to adverse climatic conditions (Berbee, Zarnstorff, and LaMadeleine, 1980). Stunted seedlings in a western nursery were more susceptible to infection and death caused by a species of Phoma (Schrago, 1976). At Eveleth Nursery in Minnesota, however, little mortality was noted but many stunted seedlings failed to meet grading specifications and would either have to be grown an additional year or discarded as culls (LaMadeleine, 1980).

The cause(s) of the stunting is still not known. In Region 5, S&PF investigators have reduced stunting by introducing mycorrhizae into the seedbeds prior to seeding (Schrago 1976). This would support the theory that a lack of mycorrhizae was the cause of the problem. In the investigations at Eveleth Nursery and at the Wisconsin State Nurseries, affected seedlings had about 15% more rootlets mycorrhizal than did non-affected seedlings (Berbee et al.)

Relative to fertility, the author has not seen significant differences between stunted and non-stunted seedlings in nutrients in the soil but has found differences in nutrient concentration in the foliage. There could be a relationship between stunting and soil characteristics with a resultant reduction in nutrient availability or uptake by the plant. This has not been pursued.

The role of Phoma has not been resolved. The work done in the West suggests that Phoma is an agent of secondary action, attacking only seedlings which are stunted. Phoma was not considered significant in the Lake States (Berbee et al.). However, in those investigations, the isolations were made from 1-0 stock, and therefore, Phoma may not have yet infected the stock. This would support the "secondary action" hypothesis.

Damping-off

Since damping-off appeared to be significant only at Southern Michigan Nursery, damped-off seedlings from that nursery alone were used for isolations. Fusarium oxysporum, Fusarium roseum var sambucinum, and Fusarium solani were all isolated from the affected seedlings. Of these three species, F. solani was the only one isolated from affected but not from non-affected seedlings. The other species were isolated almost as frequently from both affected and non-affected seedlings.

Assessing pathogenicity from isolations alone is not possible with Fusarium. Most species have both pathogenic and non-pathogenic forms. Only pathogenicity tests could prove any pathogen to be primary. Until that time, all have been shown to have a capacity for pathogenicity and should be considered possible pathogens (Vaartiaja, Cram, and Morgan, 1960; Buxton and Word, 1962).

White pine chlorosis and mortality

Species of Fusarium isolated from chlorotic 1-0 white pine were the same as from damped-off red pine, except that F. roseum var sambucinum was more abundant than F. oxysporum or F. solani. In 2-0 white pine, however, F. solani was isolated from only 2% of the root samples whereas F. oxysporum was isolated from 50-60% (equal numbers from affected and non-affected seedlings). Two other species, F. roseum var equisetti and F. roseum var acuminatum, were also isolated. Again, the roles of these fungi is unclear. They have been shown to be associated with stunting of conifer seedlings but were not isolated consistently enough in this evaluation to indicate their role as primary pathogens.

Neither Rhizoctonia or Cylindrocladium were isolated during this evaluation. Although a general medium was used, it is possible that they might have been present but not isolated. Palmer and Nicholls (1980), working on the same type of problem in Wisconsin nurseries, imply that Cylindrocladium may be a major factor.

Red pine bud mortality

The bud mortality noted in this evaluation appeared to be due to a bud mining insect. However, the insect was not present so the exact cause is unknown. There was not significant mortality associated with this problem, but the affected seedlings were shorter than non-affected seedlings and might have been culled during the grading process.

CONCLUSIONS

1. Losses of seedlings due to insects and diseases are no greater in the Michigan State Nurseries than in other Federal or State nurseries in the Lake States.

2. This evaluation does not indicate the need for a change, at this time, in management practices relative to disease control.

3. Between 13 to 30 percent of the 1-0 red and white pine showed some degree of stunting. An even higher percentage of white spruce was affected. Although preliminary information indicates the potential for significant losses due primarily to increases in culls (much less apparent than mortality), the data is not sufficient to clearly demonstrate justification for an expanded research effort or to suggest methods for control.

4. Damping-off could be a potential problem at the Southern Michigan nurseries. A number of Fusarium spp. were isolated, but verification by pathogenicity tests were not done.

RECOMMENDATIONS

1. The impact of stunting on conifer seedlings should be pursued. Losses due to mortality as well as increased number of culls should be investigated and the economic impact determined.

2. Causes of stunting should be pursued if there is an economic justification. The role of mycorrhizae, the relationship of soil characteristics, and the importance of Phoma sp. as agents causing mortality in 2-0 stock are possible areas of investigation.

3. Red pine beds at both nurseries should be monitored and the cause of bud mortality determined.

4. At Southern Michigan Nursery, where fumigation with Mylone is a normal practice, trials with methyl bromide might be conducted to see if such treatment might reduce damping-off in red pine and stunting and chlorosis of white pine.

5. Fertilization schedules should be carefully examined at both nurseries. Excesses of nitrogen can increase the action of some root rot fungi and excesses in phosphorus can suppress mycorrhizal fungi.

6. At Wyman nursery, where beds are not fumigated and where it is the desire of the nursery manager to avoid chemical controls as long as possible, biological control methods such as variation in fertilization schedule and the use of suppressive soils might be pursued.

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